AMDROHPSat: A CubeSat for Next-Gen Thermal Subsystems

CubeSat Developer’s Workshop 2023

Jacquelyn Banh and Mike Kabot – Cal Poly CubeSat Labo

Additively
Manufactured
Deployable
Radiator
with
Oscillating
Heat
Pipes

Project Collaborators

Cal State LA

CAL STATE LA

NASA JPL

NASA
JPL
Jet Propulsion Laboratory

Background and Motivation

- High power CubeSat subsystems are thermally limited
- Space for innovation exists in CubeSat deployable radiators
  - Limited performance due to thermal choke in mechanical hinges
  - AMDROHP developed to overcome this
- AMDROHPSat aims to demonstrate technology and qualify it for future use

Spacecraft Design Progress

Concept of Operations

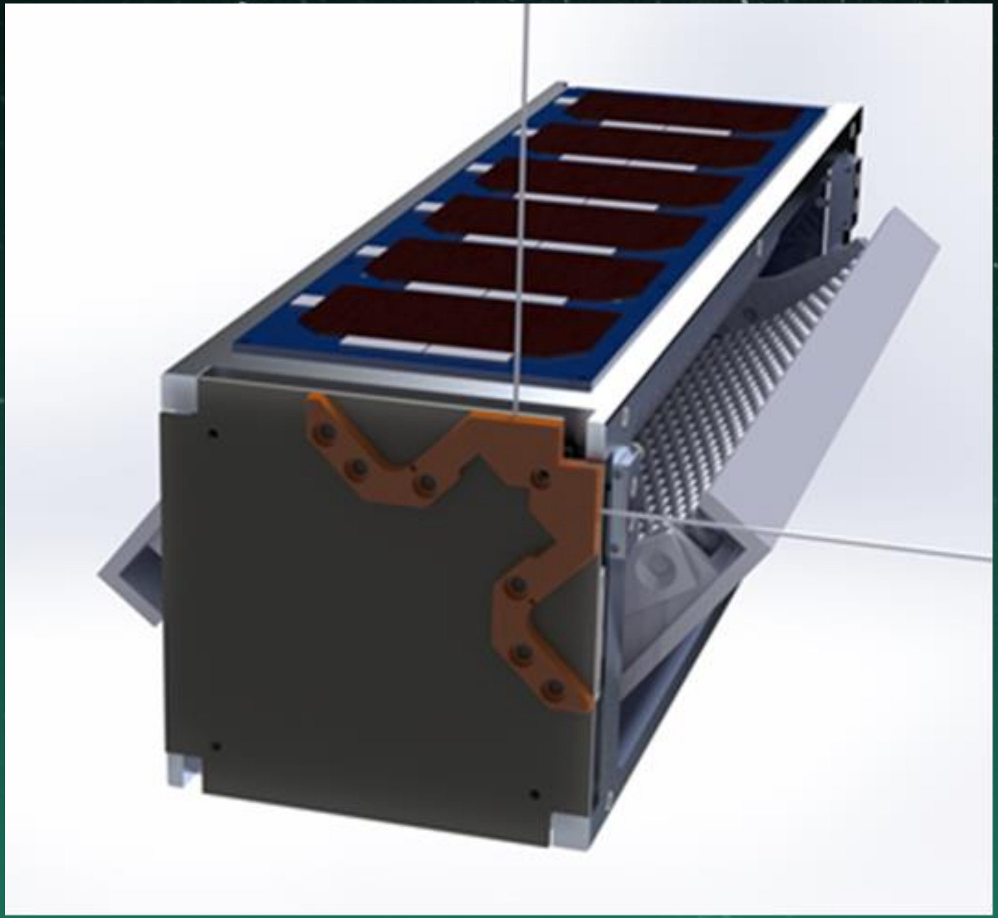
Deployment Phase

Operational Phase

1. GS command triggers the start of experiment sequence
    1. 25W of heat delivered to internal evaporator plate of 1 radiator
    2. Sequence will last 30 minutes
    3. Temperature data gathered by thermocouples on evaporator, spring section, and condenser plate
    4. Data downlinked to GS or stored and downlinked during next pass
2. S/C recharges after sequence concludes or if battery reaches minimum safe level

Decommissioning Phase

Structural Design Highlights



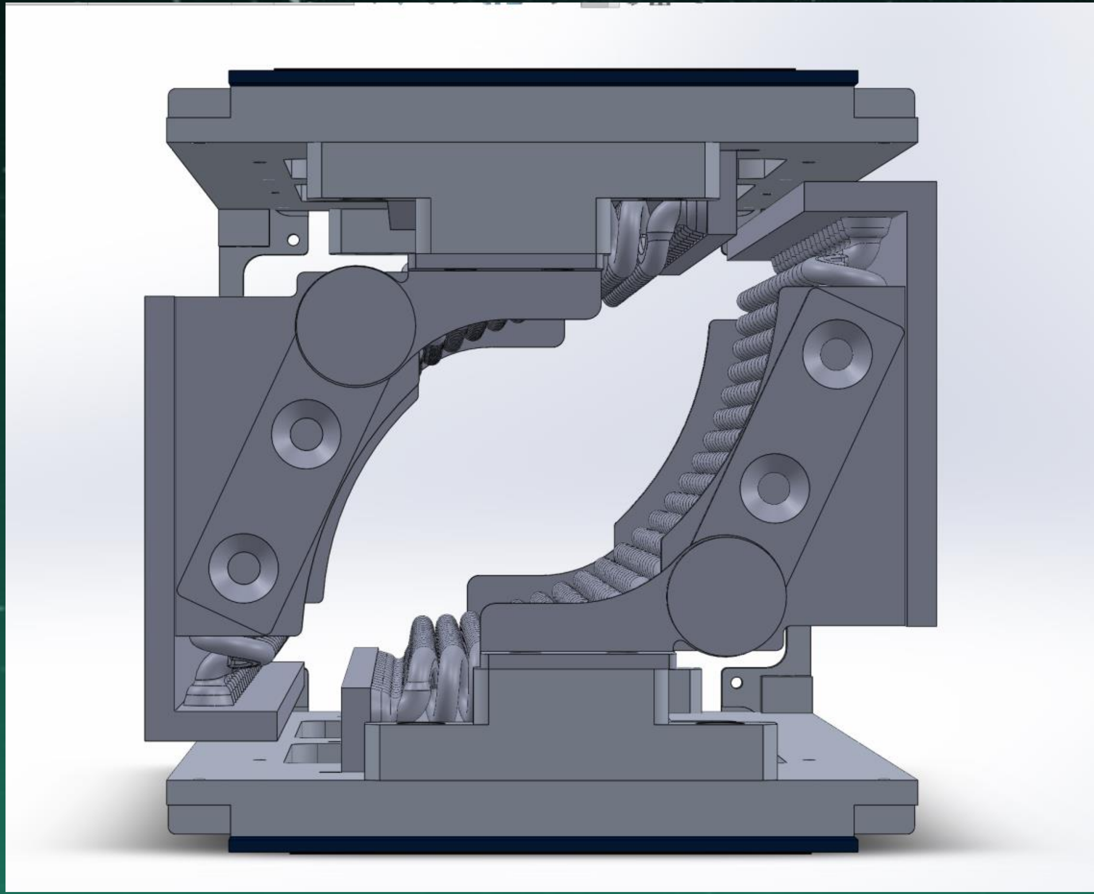
Payload

- Two additively manufactured deployable radiators located on opposites faces of the CubeSat
  - Increased heat rejection area allows for high heat rejection from a small spacecraft
  - Features a helical coil spring design
  - Comprised of a condenser plate and evaporator plate that are connected through multiple spring joints

Bus

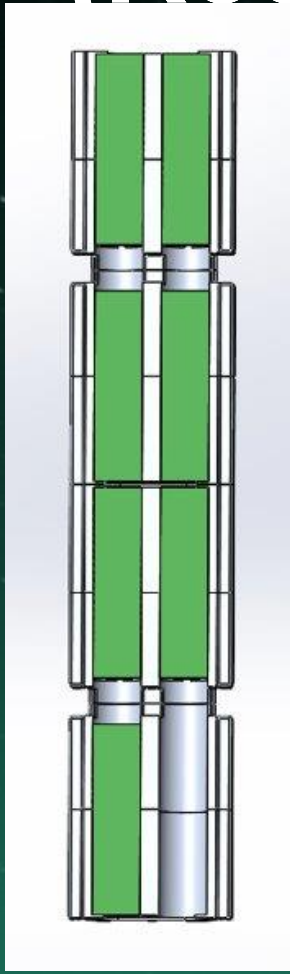
- 3U+ that features solar panels, battery bracket, passive detumble designs, and a 3 board avionics stack
- Utilizing a burn wire mechanism to deploy radiators

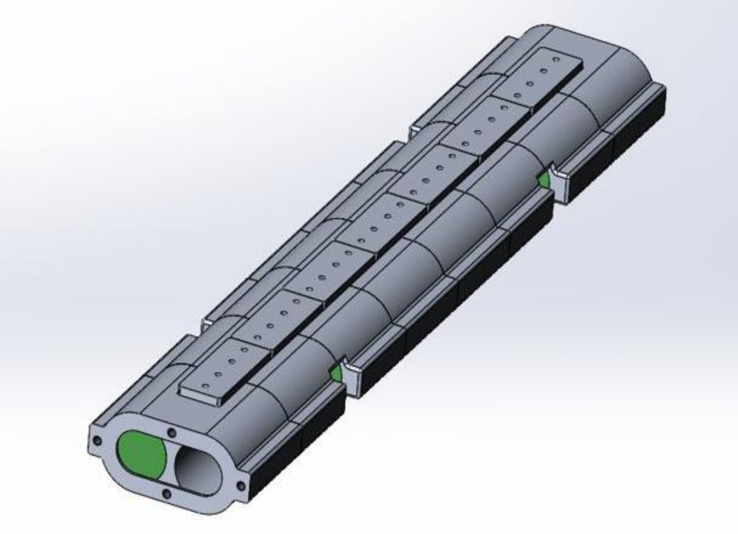
Battery Bracket Design



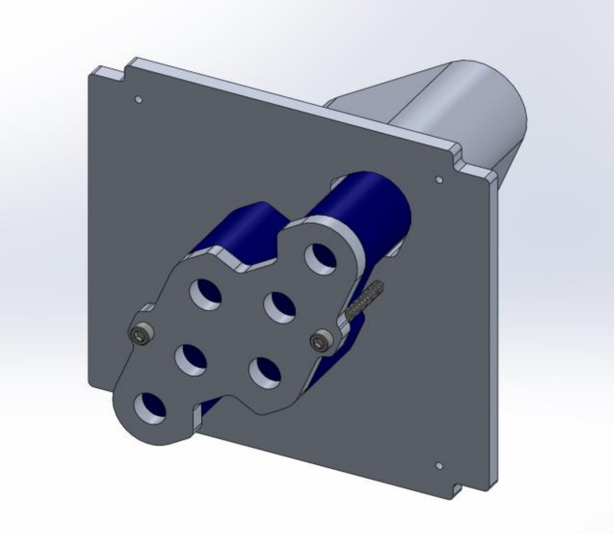
- To supply power, AMDROHPSat utilizes six 18650 battery cells
- The implementation of two radiators into the bus provides a unique set of constraints for the integration of additional hardware
- As a result, the battery bracket is constrained geometrically to a small centralized profile with few mounting routes

The Evolution of the Battery Bracket (Recent)



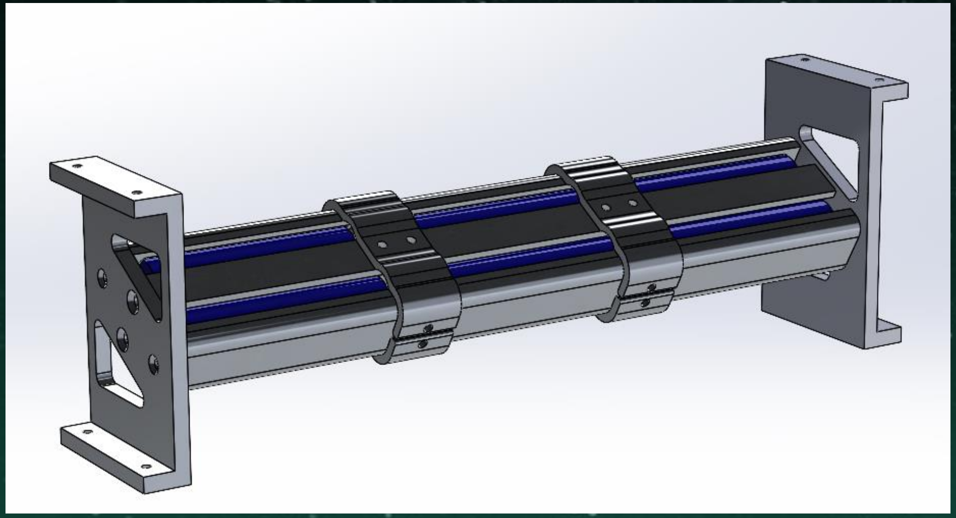


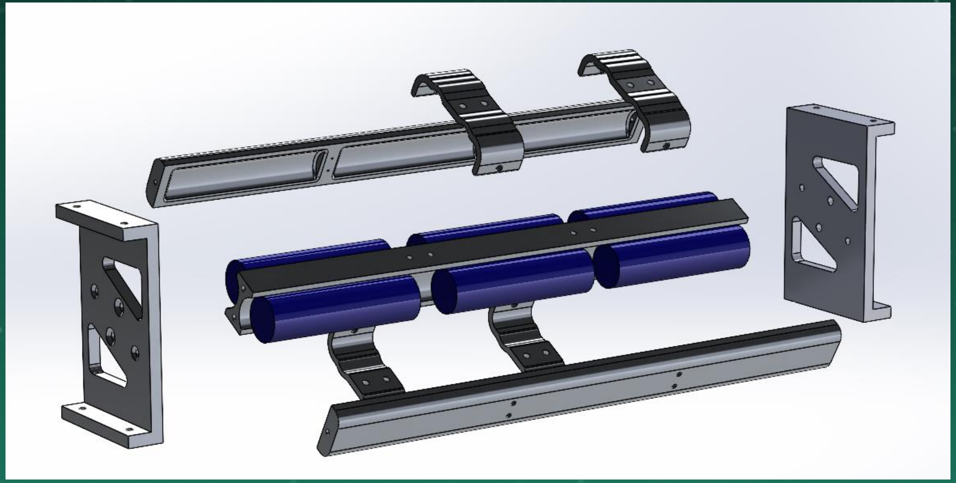
- A previous design of the battery bracket that features a modular approach
- It fully surrounds the 7 batteries due to deprecated power and thermal concerns
- It added holes for wiring, ribs for structural integrity, and secure mounting brackets
- It was reworked due to its excessively complex assembly and manufacturability in favor of a more



- Integration of battery bracket into the tuna can
- The size and geometry of the batteries prevent them from being fully seeded into the tuna can
- The batteries protrude into the payload space
- We could not find smaller batteries that met mission and power criteria

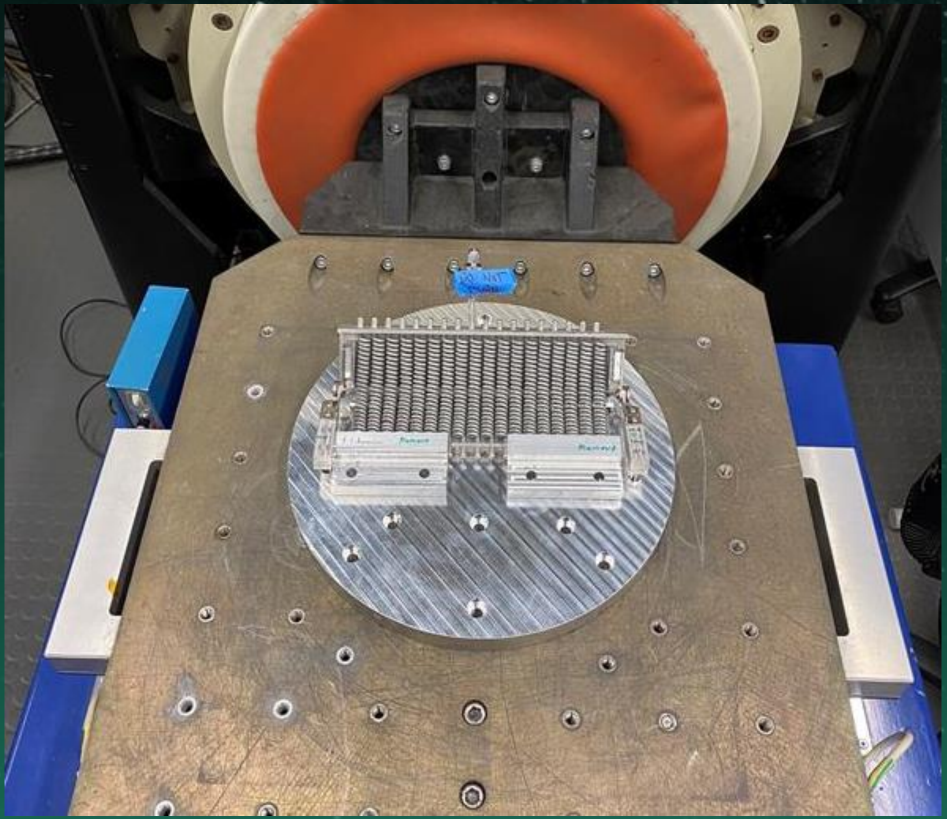
Current Battery Bracket Design





- Battery sheathe is suspended along the central axis of AMDROHPSat in between the radiators
- Batteries are sandwiched by 3 main components machined to their profile
- 4 clips hold them together radially to provide stability and double as a cable raceway/harness
- At the ends of the battery sheathe are brackets that connect the battery assembly together and mount them to the side rails of the satellite with triangle

Vibration Testing



Objective:

- To verify the payload can withstand launch loads, verify the payload's resonance, evaluate the response

Vibes Testing:

- Sine Sweep Test
  - Inputs a sine forcing function into the system from 5 Hz to 2000 Hz
- Random Noise Test
  - Sweeps through frequencies of 20 Hz to 2000 Hz

Future Plans

- Execute vibration testing on payload in stowed configuration
- Optimization and iteration of battery bracket design
  - 3D printing prototypes to test wiring and assembly
- Testing and integration of burn wire deployment mechanism
- Flatsat to verify electronic systems and software
- Finite Element Analysis, tolerancing, and finalization of structures
- CNC manufacturing and assembly

Thank You!